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Progressing the rights to light debate - Part 2: The grumble point revisited

Abstract

Purpose – The paper examines the origins of the so-called "grumble point" (a sky factor of 0.2 per cent) as the measure of daylight adequacy in rights to light disputes. It seeks to identify the rationale, and underlying scientific basis, for the adoption of this standard in the early 20th century.

Design / Methodology / Approach – Analysis of archive materials.

Findings – The use of the 0.2 per cent standard does not appear to be based on empirical investigations involving human perceptions of adequate light. No evidence exists of the investigations reputedly undertaken by Percy Waldram during the early 20th century. Waldram's own writings suggest that the standard began as a "rule of thumb" and was only later justified by reference to other independent reports. These generally do not support the use of the standard and, in any event, were soon superseded by other reports which concluded that it was too low. There is a lack of reliable evidence to justify the original adoption of the 0.2 per cent figure and many of the assumptions underpinning modern rights to light practice are found to be based on inaccurate information.

Research limitations/ implications – Continues the debate, started in this journal in 2000, about the future of surveying practice in rights to light disputes.

Practical implications – Places new information in the public domain which has implications for the professional liability of surveyors advising clients in rights to light cases.

Originality / value – Presents the first investigation into the original scientific basis for modern rights to light practice since its introduction in the early part of the 20th century.

Keywords – Buildings, Easements, Light, Measurement, Disputes.

Paper Type – Research paper.

Introduction

This is the second in a series of papers which examines the relevance of current surveying practice in rights to light disputes. The first paper (Chynoweth 2004) described the legal basis for the right to light and reviewed the methods employed by surveyors when evaluating its infringement.

The methods employed were seen to rely on the arguments proposed by Percy Waldram in the early part of the 20th century and, in particular, on his central premise that the threshold of adequate illumination was represented by a sky factor[1] of 0.2 per cent (the so-called

"grumble point"). Based on a review of archival material the current paper revisits Waldram's original arguments and re-examines some of the evidence on which they were based.

Waldram's underlying methods of measurement are uncontroversial. As early as 1909 he was proposing that interior daylight illumination should be expressed, not as an absolute value, but as a proportion of that simultaneously available from the dome of the unobstructed sky (Waldram 1909b, p. 135). Measurements were to be taken at working plane height and the unobstructed sky dome was assumed to be of uniform luminance distribution (Waldram 1928, pp. 178 & 184).

In due course these pioneering methods were officially recognised by the Commission Internationale de L'Éclairage (CIE 1929). They also continue to form the basis for the measurement of the sky factor and, with the use of the CIE standard overcast sky, for that of the modern daylight factor (BS 8206-02: 1992).

The current paper is not concerned with these underlying methods but with the way in which they are still used in rights to light cases today. It attempts to discover the rationale for the adoption of the 0.2 per cent threshold which appears so inadequate by contemporary standards. In particular, from the available archives, it seeks to identify some published evidence or contemporaneous technical guidance, which might explain why this particular standard was originally adopted.

Waldram's research

The point at which ordinary people will consistently grumble

Most surveying texts on rights to light make no attempt to explain why the 0.2 per cent sky factor is an appropriate standard (Anstey & Chavasse 1963), (Anstey 1988), (Ellis 1989). Nevertheless, it is sometimes suggested, and generally accepted by practitioners, that it is based on early empirical research undertaken by Waldram (de Burgh Sidley 2000, p.174) (Pitts 2000, p. 255). This is widely believed to have demonstrated the 0.2 per cent "grumble point" to be the threshold level of illumination below which people will consistently grumble.

Unfortunately a search for any reliable published evidence of this research proves elusive. Waldram's own writings make no more than a passing mention of any such investigations and generally, as will be discussed below, only as a preliminary to providing some more authoritative justification for the use of his chosen techniques. Of his three seminal papers -

(Waldram & Waldram 1923), (Waldram 1925), (Waldram 1928) - only two make any reference to it at all.

In his 1928 paper, delivered to the Surveyors' Institution, he briefly mentions a "laborious process of noting the opinions of ordinary people, and then measuring the light which they judge as good, adequate or inadequate" but provides no further details (Waldram 1928, p. 180). A potentially more helpful account appears in his 1923 paper, written jointly with his son and published in *The Illuminating Engineer*:

> "After some years of experience in measuring and valuing daylight illumination in a variety of cases, which have included the most diverse conditions, the authors have found no occasion to vary the opinion formed from consideration of the results obtained in the first batch of public and private buildings measured in 1912. This was that for ordinary purposes, comparable with clerical work, the natural illumination at which average reasonable persons would consistently grumble was that which represented…….0.2 per cent of the light which would fall from an unobstructed hemisphere of uniform sky on to a flat roof" (Waldram & Waldram 1923, p. 96).

Unfortunately this single reference to the 1912 investigations as the original source for the "grumble point" is contradicted elsewhere. In 1928, as will be described below, Waldram's accumulated expertise in matters relating to daylight was published as an official report (the Paterson Report) by the Government's Department of Scientific and Industrial Research (Paterson 1928). This publication identifies, and expressly references, the original source as some investigations of public and private buildings undertaken by Waldram during 1907.

In fact, an examination of the two references cited (Waldram 1909a), (Waldram 1909b) fails to support the claim made in the text. Whilst they do indeed record a series of investigations in public and private buildings during 1907, these simply relate to some of Waldram's pioneering measurement work with the Trotter photometer (Figure 1). They were concerned with the measurement and recording of existing sky factor values in a variety of well-known buildings including the Houses of Parliament, the Royal Courts of Justice and the British Museum. They make no reference, either to the opinions of building occupants, or specifically to the "grumble point".

[Take in Figure 1]

Nature of investigations actually undertaken

This level of confusion, and the lack of any formal record of investigations into the threshold of adequate daylighting, does not, of course prove that they never took place. In all probability, through his rights to light consultancy work, and his related scientific investigations, Waldram would have been continuously evaluating the perceptions of building occupants in the context of prevailing daylight conditions.

However, from the available evidence, it seems unlikely that he undertook any systematic programme of investigations, or recorded his findings in a formal manner, and certainly no such findings were ever published. His 1925 paper simply refers to the 0.2 per cent threshold as an "assumption" which he has applied in rights to light disputes over many years (Waldram 1925, p. 417). The 1923 paper also acknowledges that it "has no official status and has not….been investigated by the NPL" whilst asserting that it has nevertheless "survived the drastic test of many closely contested rights to light cases" (Waldram & Waldram 1923, p. 96).

His conclusions therefore appear to be based on impressions gained whilst undertaking his various professional activities rather than on empirical and independently verifiable scientific observation. As such, without some corroborating support form other authorities, they are probably not the reliable basis for practice in rights to light cases that they are often assumed to be. For this reason, as will be discussed below, Waldram was often at pains to substantiate his informal conclusions by reference to a number of official reports and recommendations.

Before these are examined in more detail a further issue should briefly be explored that might also have some bearing on the origins of the 0.2 per cent "grumble point". This concerns the relationship between the 0.2 per cent figure and absolute levels of illumination, now measured in lux but historically expressed in foot candles (Table I).

[Take in Table I]

Relationship between proportional and absolute measurements

The 0.2 per cent sky factor

As described above, Waldram's methods of measurement express interior daylight illumination as a proportion of total available external daylight (a "sky factor") rather than by reference to an absolute value. The 0.2 per cent "grumble point" therefore represents a level of interior daylight equivalent to 0.2 per cent of that simultaneously available outside the

building, irrespective of the actual quantity of light available from the sky at any particular moment.

This methodology reflects the capacity of the human eye to adapt to changing levels of sky luminance due to seasonal variations and weather conditions. A particular sky factor should therefore always be perceived as representing the same level of illumination, whatever the actual measurement of illumination in absolute terms (Waldram 1928, pp. 177 - 178).

On this basis absolute levels of illumination should logically have played no part in determining the value of the threshold level of adequate illumination. Indeed, the only appropriate method for such an exercise would have been the kind of empirical investigation of building occupants' perceptions which is often attributed to Waldram. If, as has been suggested, there is now some doubt about the precise nature of these investigations it does raise the question as to how Waldram actually arrived at his 0.2 per cent threshold.

A review of the relevant archive material provides a possible answer which certainly runs contrary to expectations. This suggests that he may have taken an absolute level of illumination as his starting point, and that his "grumble point" may simply have been extrapolated from this.

1 foot candle

This absolute level of illumination is referred to in his 1925 and 1928 papers and is now rarely questioned by practitioners. For reasons which are not explained he proposed an illumination level of 1 foot candle (approximately 10 lux) "as the average minimum requirement of adults for clerical work and for ordinary purposes" (Waldram 1925, p. 417). He conceded that this was lower than generally recommended but justified it after "making due allowance for the fact that some self-constituted authorities are financially benefited by high degrees of illumination" (Waldram 1925, p. 417).

The nature of these other recommendations is not known but the equivalent modern value, contained in BS 8206-02: 1992, is 500 lux (approximately 50 foot candles). The 1 foot candle / 10 lux figure proposed by Waldram is therefore surprising. It is more surprising that he then appears to have used this absolute figure as a basis for calculating the proportional value represented by the "grumble point".

This suspicion first arises from an apparent coincidence of figures in Waldram's various papers. Although the practice has since been discontinued, a value of 500 foot candles

(approximately 5000 lux) was attributed to the standard uniform sky which was used in the UK between the wars (CIE 1929, p. 473). This was a conservative design assumption which reflected average conditions of sky brightness on moderately overcast days for much of the year between 9.00 am and 3.00 pm (Paterson 1935a, p. 4). Coincidentally or otherwise, Waldram's 1 foot candle of illumination received from a sky of 500 foot candles represents exactly 0.2 per cent of the available outside light. Although this may indeed be simply a coincidence it does raise the question as to which value was arrived at first.

Which came first?

The answer may be provided by Waldram's earlier writings which describe his 1907 investigations with the Trotter photometer. These predated the use of the 500 foot candle uniform sky and were instead based on the assumption that the sky was one thousand times brighter than the readings produced by the photometer (Trotter 1911, p. 247). Even at this early stage, he was advocating a threshold level of illumination of 1 foot candle. However, as he then believed that that the sky was twice as bright as he later came to accept, it is interesting to note that he equated this with a sky factor of 0.1 per cent rather than the 0.2 per cent which he later came to advocate:

> "A rough working rule would be that all parts of a room should have a minimum illumination of 1 candle foot between sunrise and sunset….For instance an office enjoying a proportion of [0.1 per cent] of the outside illumination in the centre of the room might be regarded as reasonably well lit…" (Waldram 1909a, p. 471).

This does cast further doubt on the possibility that the 0.2 per cent grumble point was entirely a product of the opinions of ordinary people. Measurements which were purportedly based on human perceptions, and then verified by reference to proportional readings from the Trotter photometer, would have been unaffected by the amount of illumination actually available from the sky. The fact that Waldram chose to double the value of his "grumble point" at precisely the time when the official value of the standard uniform sky was halved does tend to suggest that the connection between the two was other than coincidental.

Official support for the "grumble point"

Official recognition

Despite these doubts about its origins the "grumble point" received widespread official recognition during the 1920s and early 1930s as a valid measure for the threshold of adequate daylight. Whatever the deficiencies of this particular measurement, the totality of Waldram's

pioneering work into daylighting was widely respected and he appears to have been an impressive and persuasive figure within the relevant circles of the day. In 1922 his expert witness testimony was commended by the Justice Eve in *Charles Semon & Co v Bradford Corporation* as having been given with "commendable impartiality and with great lucidity"[2] and this led to the general acceptance of his methodology in rights to light cases.

As previously mentioned, his prominence in the field also resulted in an invitation to contribute a report (the Paterson Report) for publication by the Government's Department of Scientific and Industrial Research (Paterson 1928). As the substance of his 1923 and 1925 papers was incorporated into this official publication Waldram was then able to declare that his methods had been placed "beyond dispute" (Waldram 1928A, p. 176) and this sentiment appears to have been generally accepted.

The widespread acceptance of the "grumble point" may partly be a function of the general esteem in which Waldram was held, and of the charismatic way in which he presented his ideas. However, his arguments also give the impression of being well supported by independent evidence which he skilfully weaves into his various narratives. His approach, in each case, is to show how his own tried and tested techniques have subsequently been vindicated by three independent reports into the adequacy of daylight in schools, factories and offices. These arguments have hitherto been taken at face value and the extent to which the various reports support the 0.2 per cent figure has never been examined. Each of the three reports will therefore now be considered in this context.

Report on the daylight illumination of schools

The first report on which Waldram relies was published in 1914 and related to a series of investigations by the Illuminating Engineering Society into the adequacy of daylight in public elementary schools (Gaster 1914). Both his 1923 and 1925 papers make reference to this and he notes that his use of the 0.2 per cent figure "received a valuable and welcome confirmation" from the Society's findings in these investigations (Waldram 1925, p. 417).

In fact, the Society's recommendation was actually for a minimum sky factor of 0.5 per cent (Gaster 1914, p. 361) which is two and a half times more than that proposed by Waldram. Despite this discrepancy he maintained that the Society's figures nevertheless supported his own as their investigations had been concerned with the needs of young children whilst he had been addressing the requirements of adults.

There are references throughout Waldram's work to the need for additional light "for….the eyes of very young children in schools" (Waldram 1925, p. 417) so this presumably explains the following reference to the school report, which he clearly sees as providing support for his own position:

> "A minimum of [0.5] per cent on the worst desk of public elementary schoolrooms was recommended in 1914 after searching enquiry by the Committee of this Society…..As this school minimum is two and a half times the suggested minimum for ordinary clerical work, the latter would appear to be not unreasonable." (Waldram & Waldram 1923, p. 96)

It is not known if there is any medical basis for Waldram's assumption that adults require lower levels of light than children. However, it does appear to contradict the general experience that increased lighting is required as eyesight declines with age.

Report on lighting in factories and workshops

The second report, published in 1915, recorded the findings from an extensive Home Office survey of lighting conditions in factories and workshops (Home Office 1915). According to Waldram the use of the 0.2 per cent "grumble point" was "more or less confirmed by the data of existing conditions in factories" contained in this report (Waldram & Waldram 1923, p. 98).

The report is a substantial document. It contains a vast quantity of data in respect of a large number of building types and all of this is then analysed in detail within the body of the document. Although it reports on existing lighting conditions it expressly declines to recommend particular standards of illumination until further investigations have been undertaken (Home Office 1915, p. 3). In this context it is extremely difficult to verify Waldram's rather vague claim that the report "more or less" confirms his own conclusions.

Nevertheless, the report does record an average sky factor, for existing factories with side lighting, of 0.25 per cent (Home Office 1915, p. 41). This appears to be the figure which Waldram relies on as he also refers to it in his evidence in *Charles Semon & Co v Bradford Corporation* [3] and it is certainly close enough to his own 0.2 per cent recommendation to provide some corroboration for it.

However, it is difficult to see how this could form the basis for a credible recommendation of adequate illumination. The 0.25 per cent figure relates only to premises which rely entirely on

side lighting for their daylight illumination. In practice, because of the large floor areas of factory premises, it is rarely possible to achieve satisfactory levels of daylight from side lighting alone. Indeed, the report notes the low value of this particular measurement and, by implication, recognises that it does not represent an appropriate level of illumination:

> "The extremely low value of the mid-point for this curve…..demonstrates the comparative inefficiency of side lighting for floor or general illumination (Home Office 1915, p. 40).

The 0.25 per cent figure is therefore untypical of factory lighting conditions at the time and the level of illumination was significantly higher than this in the majority of factories surveyed. Indeed, the average sky factor for those with combined side and roof lighting was 1.8 per cent whilst that for roof lighting only was 2.3 per cent (Home Office 1915, p. 41). On this basis it is difficult to see how the report's findings can properly be said to support the 0.2 per cent "grumble point" as a meaningful indicator of adequate daylight.

Report on daylight illumination required in offices

The final report records the results of investigations into the minimal acceptable levels of daylighting required for clerical work. These were undertaken in government offices during 1928 by the Department of Scientific and Industrial Research (Taylor 1931) and the report initially appears to provide the elusive scientific underpinning for Waldram's position which this paper has been seeking.

Waldram was already anticipating its findings when he delivered his paper to the Surveyors' Institution in 1928. Whilst acknowledging that his 0.2 per cent figure "may seem a little low according to textbooks on artificial lighting" he confidently predicted that it would soon be endorsed "in view of comprehensive tests in government offices" (Waldram 1928, pp. 180-181).

This endorsement was duly delivered when the published report concluded that its findings were: "so close to that which has been used for a considerable time past in ancient lights cases, viz, 0.2 per cent, that this may be taken as the value to be adopted for most practical purposes" (Taylor 1931, p. 9). Official recognition for the "grumble point" then appeared to be complete when, in 1932, a formal reference to these investigations was included in the second edition of the Paterson Report. In words that are reminiscent of those previously used in support of Waldram's contentions the author records that:

> "Comprehensive tests in offices have established the fact that reasonable people will grumble at a point enjoying only 0.2 per cent [sky] factor, not only in dull but also in fine weather" (Paterson 1932, p. 10).

The "grumble point" was therefore not simply recognised as the official standard of adequate daylighting. It had also now acquired precisely the scientific pedigree that it had long coveted but had never previously been able to demonstrate. The tone of the report itself suggests that the right result had been achieved from the investigators' points of view and the preface notes that "it is gratifying to find that the figure arrived at as a result of this work is in excellent agreement" with that previously adopted by Waldram (Taylor 1931, p. iii).

Nature of office investigations

The results of these investigations are so unequivocal, so convenient for the Waldram thesis, and so inconsistent with some of the other findings of this paper that they deserve further scrutiny. Fortunately the research and its methodology are described in detail within the report.

The study sought to identify human perceptions of the threshold of adequate daylight in twenty different rooms within the New Government Building, Whitehall. Prior to the tests each room was "carefully surveyed photometrically" and plans were produced for each, showing the sky factor contours for 0.5 percent, 0.25 per cent and 0.1 per cent (Figure 2). The subjects were then provided with a blank plan of the rooms and asked to draw their own contour on it representing the division between the adequately and inadequately lighted portions of the room.

[Take in Figure 2]

The graphical data from each plan was then analysed and expressed numerically as a single sky factor value. The results from all subjects were then plotted as a frequency distribution curve to demonstrate the most frequently recorded sky factor values. The peak of the curve was found to occur at a sky factor of approximately 0.16 to 0.19 per cent and, in view of its proximity to the traditional 0.2 per cent figure, the report concluded that the latter value should be adopted.

Commentary

The most surprising aspect of the investigation was its choice of subjects. Rather than recording the opinions of actual building occupants the study relied overwhelmingly on the

opinions of what it describes as a “jury” of seven professionally qualified experts. This was said to consist of three architects, two illuminating engineers, one further engineer and an accommodation officer from HM Office of Works. Although the study did record an occupier’s opinion for each room, in each case this was matched by thirteen opinions from the expert jury.

The actual composition of the expert jury produces further surprises and certainly raises doubts in the context of scientific objectivity. One of these (J W T Walsh) was in the unusual position of acting as a subject in the investigation whilst simultaneously serving as a member of the committee which was undertaking the research. Even more bizarrely, two of the others are shown to be none other than Percy Waldram and his son J.M Waldram.

Other aspects of the investigation also raise questions about its objectivity. It had always been maintained that standards of illumination should be defined by reference to “moderately dull but not abnormally dull weather” (Waldram 1925, p. 416), (Waldram 1928, p. 178). It is therefore unclear why the data from the expert jury which was collected on a dull day (with mean results in excess of 0.2 per cent) had to be matched by further data collected on a bright day. The effect, of course, was to suppress the overall results as lower results were predictably recorded on the day when the sun was shining (Taylor 1931, p. 9).

One is bound to question whether the preconceptions of both the research team and the expert jury influenced the process and outcome of the investigations. Certainly, it is interesting to note the proximity of the data collected from the two Waldrams (a mean of 0.22 per cent) to their long-advocated “grumble point”. And of course the more general question remains as to why a jury, composed of people with so obvious an interest in the outcome, should be better trusted to deliver a verdict on the “grumble point” of building occupants than the building occupants themselves.

One might also question the purpose of the pre-prepared plans showing the 0.5 per cent, 0.25 per cent and 0.1 per cent sky factor contours (Figure 2). These apparently played no part in the investigations themselves but appear to anticipate a range of results within a comparatively narrow band on either side of the 0.2 per cent contour. It is not possible to determine whether the subjects were guided into this band. Nevertheless, it is strange that none of the results strayed into the 2 per cent region identified as common by the 1915 Home Office Report on factories, or even into the 0.5 per cent band recommended for schools in 1914.

The detailed findings and methodology of these investigations are a matter of record and are central to the credibility or otherwise of the 0.2 per cent threshold. It is hoped that others might now subject them to further scientific scrutiny, and perhaps also undertake similar experiments to those described, in order to test their reliability. However, for the various reasons explored above, it is suggested that they cannot presently be regarded as providing the convincing evidence in support of the "grumble point" that was once claimed.

Subsequent developments

Rejection by the Commission Internationale de L'Éclairage

Although the 0.2 per cent threshold continues to be used in rights to light cases today its credibility as a more general indicator of daylight adequacy began to decline soon after the publication of the report on office illumination in 1931.

Despite its widespread acceptance in the UK during the 1920s and early 1930s it is noticeable that the 0.2 per cent figure was never recognised internationally. Indeed, despite suggestions to the contrary (Anstey & Chavasse 1963, p.38), it was actually rejected as a standard of adequacy at the Cambridge meeting of the CIE in 1931.

The British delegation (which included Waldram) had argued for its adoption at both the 1928 and 1931 meetings but had met with opposition from some of the other delegations (CIE 1932, pp. 219 & 223). Although a compromise resolution at the 1931 meeting recorded that a sky factor of less than 0.2 per cent was "definitely inadequate" the same resolution is quite unequivocal in its statement that "this is not recommended as a standard of adequate intensity of illumination" (Paterson 1932, p. 1).

Further investigations in government offices

It is not known if concerns then started to be expressed about the legitimacy of the earlier office research but the Department of Scientific and Industrial Research undertook further investigations into daylight illumination in offices during the winter of 1935/36. The results were published as a report in 1937 and this records that "some of the minimum standards of illumination suggested in the past are much too low" (McDermott 1937, p. iii).

These findings were based on further investigations in Whitehall offices which sought to identify the threshold level of daylight illumination at which clerical workers found it necessary to turn on the artificial light. In co-operation with HM Office of Works it was arranged that typists in one of the government typing offices should have their desk lights

fitted with a device which, unknown to them, would record the level of illumination at their desk at the moment the light was switched on.

The data was collected over a number of months and the mean value of illumination at which additional artificial light was required was found to be 5 foot candles, or approximately 50 lux (McDermott 1937, pp. 10 & 14). This threshold level of daylight illumination was therefore five times greater than the one foot candle figure proposed by Waldram, and which had apparently been supported by the earlier investigations in government offices. If this figure is related to the 500 foot candle uniform sky used in the 1930s it will be seen to equate to a sky factor of 1 per cent rather than the 0.2 per cent traditionally relied on.

Post war building studies

The post war reconstruction effort provided the impetus for the next report by the Department of Scientific and Industrial Research which was published in the government's *Post-War Building Studies* series (LCBRB 1944). This reviewed the existing state of knowledge relating to the natural and artificial lighting of buildings and recommended appropriate standards for housing in the post war era.

Its recommendations for daylight illumination were consistent with the findings of the 1937 report into offices and these were, once again, considerably in excess of the 0.2 per cent figure proposed by Waldram. A sky factor of 1 per cent was recommended for living rooms with appropriate adjustments for bedrooms (0.5 per cent) and working kitchens (2 per cent) (LCBRB 1944, p. 39). A later report examined office buildings and, for areas relying exclusively on daylight, this too recommended a minimum acceptable sky factor of 1 per cent (LCBRB 1952, p. 13).

[Take in Table II]

Conclusions

This paper has revisited the origins of the so-called "grumble point" as the measure of daylight adequacy in rights to light disputes. It has explored the rationale for the original adoption of this standard and has sought to identify its underlying scientific basis.

As expected, its findings confirm the central role played by Percy Waldram in pioneering the current methods, and in advocating the adoption of the 0.2 per cent sky factor as the threshold of adequacy. The reasons why he chose this particular value have been more difficult to

ascertain. Despite a widespread belief to the contrary there is little evidence that he undertook any systematic investigations which established it as the point of illumination below which people will consistently grumble. Indeed, his own writings suggest that he adopted the 0.2 per cent figure as a convenient hunch, or "rule of thumb", rather than on the basis of particular empirical evidence.

In fact, the evidence indicates that he originally advocated a sky factor of 0.1 per cent as his "grumble point" and that he later changed this to 0.2 per cent when 500 foot candles was adopted as the recognised value for the standard uniform sky. Although no published evidence of the 0.2 per cent figure appears until 1922 it is clear that he had been recommending a daylight threshold of 1 foot candle since at least 1909. It seems likely that the 0.2 per cent figure may owe as much to the relationship between this longstanding recommendation and the newly recognised sky value as it does to any reliable data about the point at which people begin to grumble.

Most of the evidence in support of the 0.2 per cent figure actually takes the form of references to independent third party reports in Waldram's various publications. Of the three reports relied on two of them are actually found to contradict his own recommendations. The 1914 report on school illumination recommended a figure two and a half times greater than his own whilst that in the 1915 report on factories was in the region of ten times greater.

Although the 1931 report on offices initially appears to provide an endorsement of the 0.2 per cent threshold there are significant doubts about the reliability of this research which, in any event, was superseded by a second office report in 1937. This concluded that the earlier recommendation had been too low and proposed a figure equivalent to 1 per cent sky factor, or five times greater than that proposed by Waldram.

The nature of daylight is such that it is not easily reduced to hard and fast figures. For this reason the various recommendations should probably all be treated with caution and there is clearly some scope for flexibility when interpreting them. Nevertheless, the absence of any reliable corroborating evidence for the 0.2 per cent figure, and the extent to which all other evidence points towards a higher figure cannot be ignored. The unreliability of many of the statements made in support of the 0.2 per cent threshold should also be a matter of concern.

In conclusion, this paper suggests that there has always been a lack of scientific evidence to support the use of the 0.2 per cent sky factor as a threshold for adequate daylight. It also suggests that many of the assumptions underpinning modern rights to light practice are

founded on information which is manifestly inaccurate or even misleading. It urges rights to light practitioners to engage with the current debate and to consider whether more appropriate practices should now be adopted.

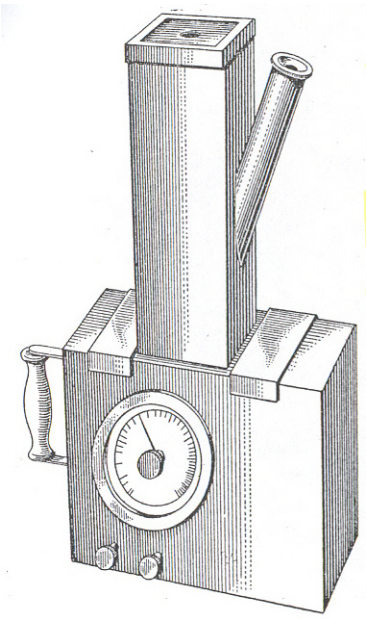

Figure 1: The Trotter Photometer, an early form daylight factor meter used by Waldram when measuring existing daylight conditions in public and private buildings during 1907.

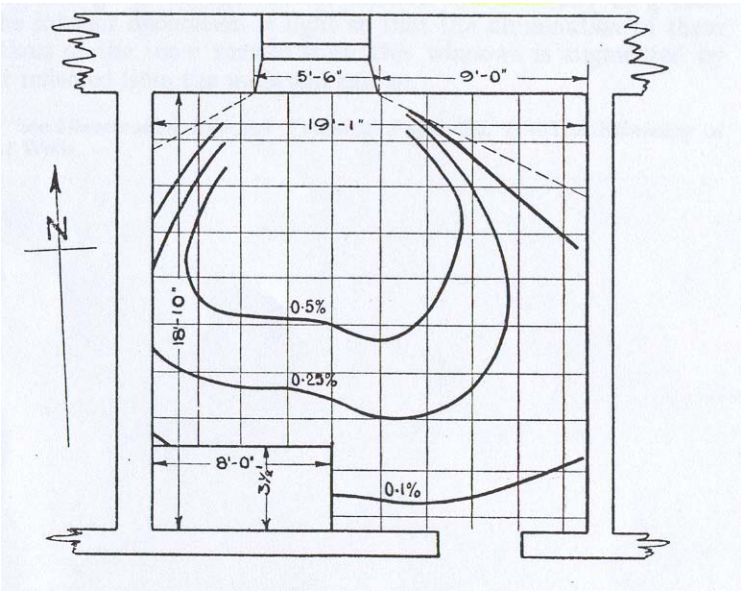

Figure 2: Pre-prepared room plan from the 1931 report on daylight in government offices which confirmed the validity of the 0.2 per cent "grumble point". The contours representing the sky factors for 0.5 per cent, 0.25 per cent and 0.1 per cent were plotted in advance of the investigations.

Explanatory Description	**Contemporary Terminology (CIE 1987)**			**Historic Terminology (Paterson 1935b)**		
	Description / Symbol		Unit	Description / Symbol		Unit
Visible radiant energy	Luminous flux	*F*	Lumen	Luminous flux	*F*	Lumen
Candle power	Luminous intensity	*I*	Candela	Luminous intensity	*I*	Candle
Surface illumination	Illuminance	*E*	Lux (lumen/m^2)	Illumination	*E*	Foot candle (lumen / ft^2)
Surface brightness	Luminance	*L*	Candela / m^2 or Apostilb (lumen / m^2)	Brightness	*B*	Candles / ft^2 or Foot-Lambert (lumen / ft^2)

Table I: Comparison of Contemporary and Historic Lighting Terminology

1907	Percy Waldram undertakes measurements of existing daylight conditions in a variety of public and private buildings with the Trotter photometer.
1909	Waldram publishes the results of his investigations and recommends that 1 foot candle should be used as a "rough working rule" to measure the adequacy of interior daylight.
1914	Publication of Illuminating Engineering Society's report on daylight illumination in schools
1915	Publication of Home Office Report on lighting conditions in factories and workshops
1922	Waldram's use of the 0.2 sky factor as a measure of the grumble point receives judicial approval in *Charles Semon & Co v Bradford Corporation*
1923	Publication of first seminal Waldram paper. 'Window Design and the Measurement and Predetermination of Daylight' is published in *The Illuminating Engineer*.
1925	Publication of second seminal Waldram paper. 'The Natural and Artificial Lighting of Buildings' is published in *The Illuminating Engineer*.
1928	Publication of third seminal Waldram paper. 'The Estimation of Damage in Ancient Lights Disputes' is presented to the Surveyors' Institution. In the same year Waldram submits a comprehensive report on daylight to the Department of Scientific and Industrial Research and this is published as *Penetration of Daylight and Sunlight into Buildings* (the Paterson Report).
1931	Publication of report by the Department of Scientific and Industrial Research on the daylight illumination required in offices. The report describes research in government offices and confirms the validity of the 0.2 sky factor. Later the same year the CIE refuse to recognise it as an appropriate standard.
1937	The Department of Scientific and Industrial Research publish the results of further research on the daylight illumination required in offices. This concludes that the previous recommendation was too low.
1944	Publication of *Post-War Building Studies No. 12: The Lighting of Buildings*. The report recommends a minimum sky factor value of 1 per cent for domestic living rooms.
1952	Publication of *Post-War Building Studies No. 30: The Lighting of Office Buildings*. A minimum sky factor of 1 per cent is again recommended for office floor areas relying exclusively on daylight.

Table II: Chronology of early Twentieth Century Daylight Research

Notes

1. This is the term used in the current British Standard (BS 8206-2: 1992). The same measurement (based on a uniform hemisphere of sky) was historically referred to as the 'daylight factor' although that term is today reserved for measurements based on the CIE standard overcast sky. Measurements were also sometimes expressed as a ratio rather than a percentage. Prior to 1928 they were based on a quartersphere, rather than a hemisphere, of sky. Rather confusingly these measurements were also generally referred to as the 'daylight factor' although the term 'sill ratio' was sometimes used as an alternative. In the interests of clarity the term 'sky factor' is used throughout this paper and all measurements are expressed on this basis, irrespective of the terminology used in particular source materials referred to.

2. *Charles Semon & Co v Bradford Corporation* [1922] 2 Ch 737, at 746

3. *Ibid*, at 747

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